Application No.: 09/846,150
Response dated: July 19, 2004
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In the Claims:

Please replace claims 1 and 16, and add new claims 35-66 all as shown below.

1. (Currently amended) A method of fabricating a multilevel EUV optical element comprising:

(a) providing a substrate;

(b) depositing a layer of curable material on a surface of the substrate;

(c) creating a relief profile in a layer of cured material from the layer of curable material wherein the relief profile comprises multiple levels of cured material that has a defined contour wherein the number of levels in the cured material is at least about 3; and

(d) depositing a multilayer reflection film over the relief profile wherein the film has an outer contour that substantially matches that of the relief profile.

2. (Original) The method of claim 1 wherein the multilayer reflection film comprises alternating layers of a first material having a refractive index and a second material having a different refractive index than the first material.

3. (Original) The method of claim 1 wherein the multilayer reflection film comprises about 10 to 200 layer pairs.

4. (Original) The method of claim 3 wherein the layer pairs have a periodicity of about 2 nm to 100 nm.

5. (Original) The method of claim 1 wherein the multilayer reflection film comprises alternating layers of molybdenum and silicon.

6. (Original) The method of claim 5 wherein the multilayer reflection film comprises about 10 to 200 layer pairs.

7. (Original) The method of claim 6 wherein the layer pairs have a periodicity of about 2 nm to 100 nm.

8. (Currently amended) The method of claim 1 wherein the curable material comprises photoresist and step (c) comprises the steps of:

(i) exposing the layer of photoresist to spatially varying doses of radiation; and

(ii) developing the photoresist to generate a layer of partially-cleared photoresist.

9. (Original) The method of claim 8 wherein the radiation comprises electron beam radiation.

10. (Currently amended) The method of claim 1 wherein the curable material comprises a low dielectric constant material and step (c) comprises the steps of:

(i) exposing the layer of low dielectric constant material to spatially varying doses of radiation to selectively modulate its dissolution rate with respect to a solvent; and

(ii) dissolving the low dielectric constant material for a sufficient length of time such that a relief structure is produced in the low-dielectric-constant material, where the relief structure depth is proportional to the modulated dissolution rate in step (i).

11. (Original) The method of claim 10 wherein the low dielectric constant material is selected from the group of materials consisting of spin on glass, benzocyclobutine, and hydrogen silsesquioxane.

12. (Original) The method of claim 11 wherein the radiation comprises electron beam radiation.

13. (Original) The method of claim 1 wherein the incremental height of each level of the multiple levels of the cured material ranges from 1 nm to 20 nm.

14. (Original) The method of claim 1 wherein the number of levels in the cured material is in the range of about 3 to 31.

15. (Original) The method of claim 1 wherein the incremental step heights of the relief profile in the layer of cured material are small relative to the intrinsic roughness of the cured material.

16. (Currently amended) An EUV device including a multilevel element that comprises:

(a) a substrate having a layer of a cured material deposited on a surface of the substrate wherein the layer of cured material defines a relief profile comprising multiple levels of cured material that has a defined contour wherein the number of levels is at least about 3; and

(b) a multilayer reflection film that covers the relief profile wherein the film has a contour that substantially matches that of the relief profile.

17. (Original) The device of claim 16 wherein the multilayer film comprises alternating layers of a first material having a refractive index and a second material having a refractive index than is different from that of the first material.

18. (Original) The device of claim 16 wherein the multilayer reflection film comprises alternating layers of molybdenum and silicon.

19. (Original) The device of claim 16 wherein the multilayer reflection film comprises about 10 to 200 layer pairs.

20. (Original) The device of claim 19 wherein the layer pairs have a periodicity of about 2 nm to 100 nm.

21. (Original) The device of claim 18 wherein the multilayer reflection film comprises about 10 to 200 layer pairs.

22. (Original) The device of claim 21 wherein the layer pairs have a periodicity of about 2 nm to 100 nm.

23. (Original) The device of claim 16 wherein the incremental height of each level of the multiple levels of the cured material ranges from 1 nm to 20 nm.

24. (Original) The device of claim 16 wherein the number of levels in the cured material is in the range of about 3 to 31.

25. (Original) The device of claim 16 wherein the cured material is photoresist.

26. (Original) The device of claim 16 wherein the incremental step heights of the relief profile in the layer of cured material are small relative to the intrinsic roughness of the cure material.

27. (Original) The device of claim 16 wherein the cured material is a low dielectric constant material.

28. (Original) The device of claim 27 wherein the low dielectric constant material is selected from the group of materials consisting of spin on glass, benzocyclobutine, and hydrogen silsesquioxane.

29. (Currently amended) The device of claim 16 which is fabricated by a process comprising the steps of:

(a) providing a substrate;

(b) depositing a layer of curable material on a surface of the substrate;

(c) creating a relief profile of cured material from the layer of curable material wherein the relief profile comprises multiple levels of cured material that has a defined contour; and

(d) depositing a multilayer reflection film over the relief profile wherein the film has an outer contour that substantially matches that of the relief profile.

30. (Original) The device of claim 29 wherein the curable material comprises photoresist and step (c)

comprises the steps of: (i) exposing the layer of photoresist to spatially varying doses of radiation; and (ii) developing the photoresist to generate a layer of partially-cleared photoresist.

31. (Original) The device of claim 30 wherein the radiation comprises electron beam radiation.

32. (Original) The device of claim 29 wherein the curable material comprises a low dielectric constant material and step (c) comprises the steps of:

(i) exposing the layer of low dielectric constant material to spatially varying doses of radiation to selectively modulate its dissolution rate with respect to a solvent; and

(ii) dissolving the low dielectric constant material for a sufficient length of time such that a relief structure is produced in the low-dielectric-constant material, where the relief structure depth is proportional to the modulated dissolution rate in step (i).

33. (Original) The device of claim 32 wherein the low dielectric constant material is selected from the group of materials consisting of spin on glass, benzocyclobutine, and hydrogen silsesquioxane.

34. (Original) The device of claim 33 wherein the radiation comprises electron beam radiation.

35. (New) A method of fabricating a multilevel EUV optical element comprising:

(a) providing a substrate;

(b) depositing a layer of curable material on a surface of the substrate;

(c) creating a relief profile in a layer of cured material from the layer of curable material wherein the relief profile comprises multiple levels of cured material that has a defined contour; and

(d) depositing a multilayer reflection film over the relief profile wherein the film has an outer contour that substantially matches that of the relief profile wherein the incremental step heights of the relief profile in the layer of cured material are small relative to the intrinsic roughness of the cured material.

36. (New) The method of claim 35 wherein the multilayer reflection film comprises alternating layers of a first material having a refractive index and a second material having a different refractive index than the first material.

37. (New) The method of claim 35 wherein the multilayer reflection film comprises about 10 to 200 layer pairs.

38. (New) The method of claim 37 wherein the layer pairs have a periodicity of about 2 nm to 100 nm.

39. (New) The method of claim 35 wherein the multilayer reflection film comprises alternating layers of molybdenum and silicon.

40. (New) The method of claim 39 wherein the multilayer reflection film comprises about 10 to 200 layer pairs.

41. (New) The method of claim 40 wherein the layer pairs have a periodicity of about 2 nm to 100 nm.

42. (New) The method of claim 35 wherein the curable material comprises photoresist and step (c) comprises the steps of: (i) exposing the layer of photoresist to spatially varying doses of radiation; and (ii) developing the photoresist to generate a layer of partially-cleared photoresist.

43. (New) The method of claim 42 wherein the radiation comprises electron beam radiation.

44. (New) The method of claim 35 wherein the curable material comprises a low dielectric constant material and step (c) comprises the steps of:

(i) exposing the layer of low dielectric constant material to spatially varying doses of radiation to selectively modulate its dissolution rate with respect to a solvent; and

(ii) dissolving the low dielectric constant material for a sufficient length of time such that a relief structure is produced in the low-dielectric-constant material, where the relief structure depth is proportional to the modulated dissolution rate in step (i).

45. (New) The method of claim 44 wherein the low dielectric constant material is selected from the group of materials consisting of spin on glass, benzocyclobutine, and hydrogen silsesquioxane.

46. (New) The method of claim 45 wherein the radiation comprises electron beam radiation.

47. (New) The method of claim 35 wherein the incremental height of each level of the multiple levels of the cured material ranges from 1 nm to 20 nm.

48. (New) The method of claim 35 wherein the number of levels in the cured material is in the range of about 3 to 31.

49. (New) An EUV device including a multilevel element that comprises:

(a) a substrate having a layer of a cured material deposited on a surface of the substrate wherein the layer of cured material defines a relief profile comprising multiple levels of cured material that has a defined contour; and

(b) a multilayer reflection film that covers the relief profile wherein the film has a contour that substantially matches that of the relief profile wherein the incremental step heights of the relief profile in the layer of cured material are small relative to the intrinsic roughness of the cured material.

50. (New) The device of claim 49 wherein the multilayer film comprises alternating layers of a first material having a refractive index and a second material having a refractive index than is different from that of the first material.

51. (New) The device of claim 49 wherein the multilayer reflection film comprises alternating layers of molybdenum and silicon.

52. (New) The device of claim 49 wherein the multilayer reflection film comprises about 10 to 200 layer pairs.

53. (New) The device of claim 52 wherein the layer pairs have a periodicity of about 2 nm to 100 nm.

54. (New) The device of claim 51 wherein the multilayer reflection film comprises about 10 to 200 layer pairs.

55. (New) The device of claim 54 wherein the layer pairs have a periodicity of about 2 nm to 100 nm.

56. (New) The device of claim 49 wherein the incremental height of each level of the multiple levels of the cured material ranges from 1 nm to 20 nm.

57. (New) The device of claim 49 wherein the number of levels in the cured material is in the range of about 3 to 31.

58. (New) The device of claim 49 wherein the cured material is photoresist.

59. (New) The device of claim 49 wherein the cured material is a low dielectric constant material.

60. (New) The device of claim 59 wherein the low dielectric constant material is selected from the group of materials consisting of spin on glass, benzocyclobutine, and hydrogen silsesquioxane.

61. (New) The device of claim 49 which is fabricated by a process comprising the steps of:

(a) providing a substrate;

(b) depositing a layer of curable material on a surface of the substrate;

(c) creating a relief profile of cured material from the layer of curable material wherein the relief profile comprises multiple levels of cured material that has a defined contour; and

(d) depositing a multilayer reflection film over the relief profile wherein the film has an outer contour that substantially matches that of the relief profile.

62. (New) The device of claim 61 wherein the curable material comprises photoresist and step (c) comprises the steps of: (i) exposing the layer of photoresist to spatially varying doses of radiation; and (ii) developing the photoresist to generate a layer of partially-cleared photoresist.

63. (New) The device of claim 62 wherein the radiation comprises electron beam radiation.

64. (New) The device of claim 61 wherein the curable material comprises a low dielectric constant material and step (c) comprises the steps of:

(i) exposing the layer of low dielectric constant material to spatially varying doses of radiation to selectively modulate its dissolution rate with respect to a solvent; and

(ii) dissolving the low dielectric constant material for a sufficient length of time such that a relief structure is produced in the low-dielectric-constant material, where the relief structure depth is proportional to the modulated dissolution rate in step (i).

65. (New) The device of claim 64 wherein the low dielectric constant material is selected from the group of materials consisting of spin on glass, benzocyclobutine, and hydrogen silsesquioxane.

66. (New) The device of claim 65 wherein the radiation comprises electron beam radiation.